Distributed Energy Perspectives

U.S. Department of Energy

Merrill Smith
Distributed Energy Resources
Office of Power Technologies
Energy Efficiency and Renewable Energy
US Department of Energy

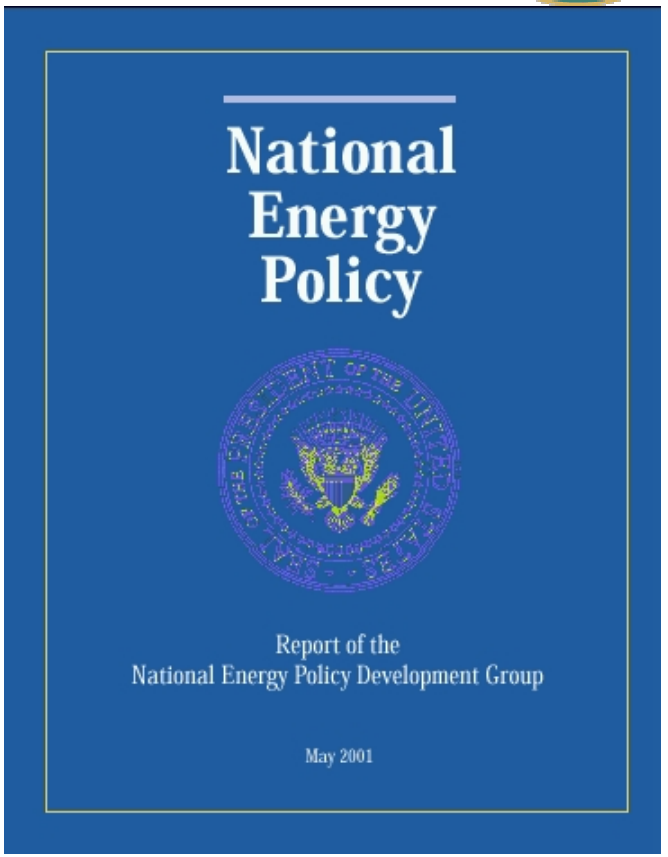
The World Has Changed…

Distributed Power Units Lower Manhattan, September 2001

The Federal Role

- Sustain economic growth
- Achieve energy security
- Protect the environment

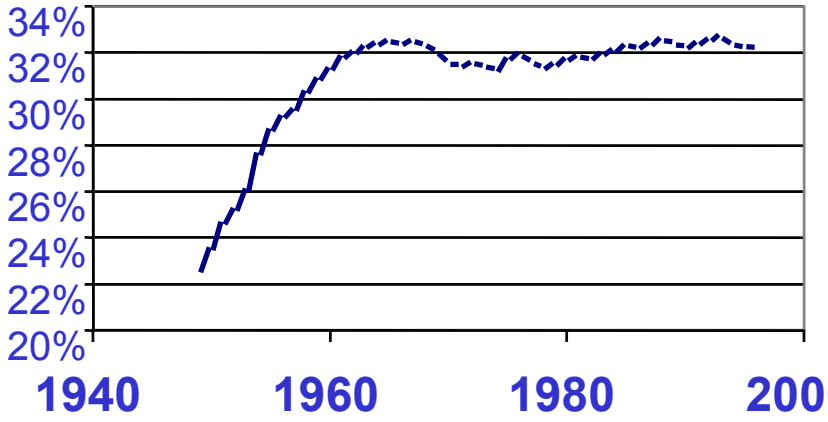
If left unmet, national electricity needs could threaten international competitiveness, public health and safety, interstate commerce, and national security.



Of the 105 total recommendations...

- 21 affect distributed energy
- 13 affect T&D
- 8 affect international activities
- 17 affect renewable energy

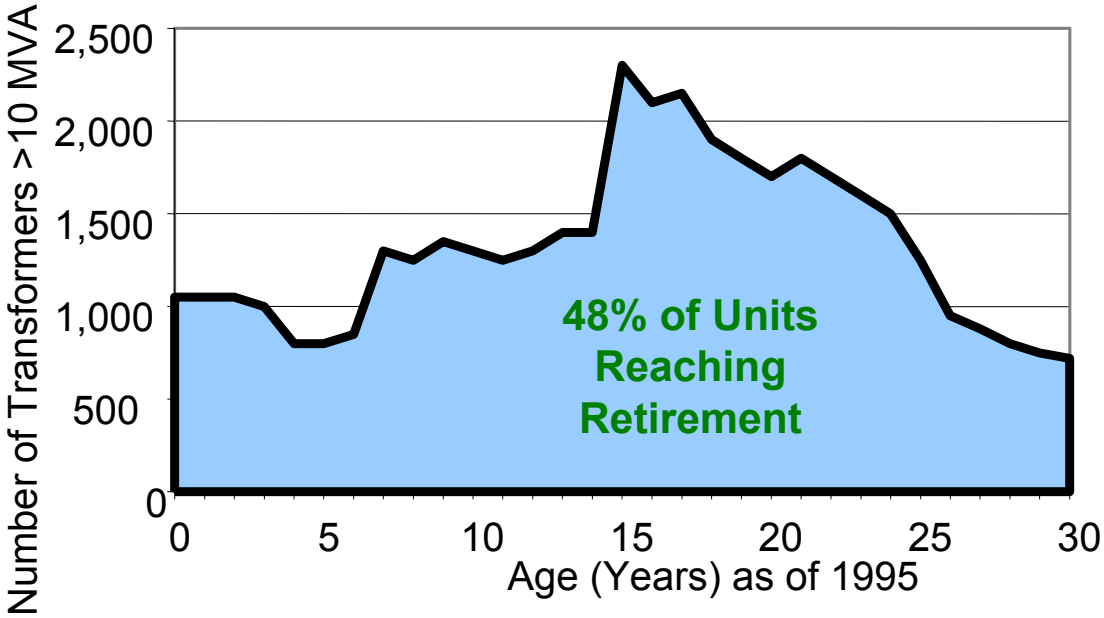
Aging Power Infrastructure



Fossil Electric Generation Efficiency (at plant, W/O T&D)

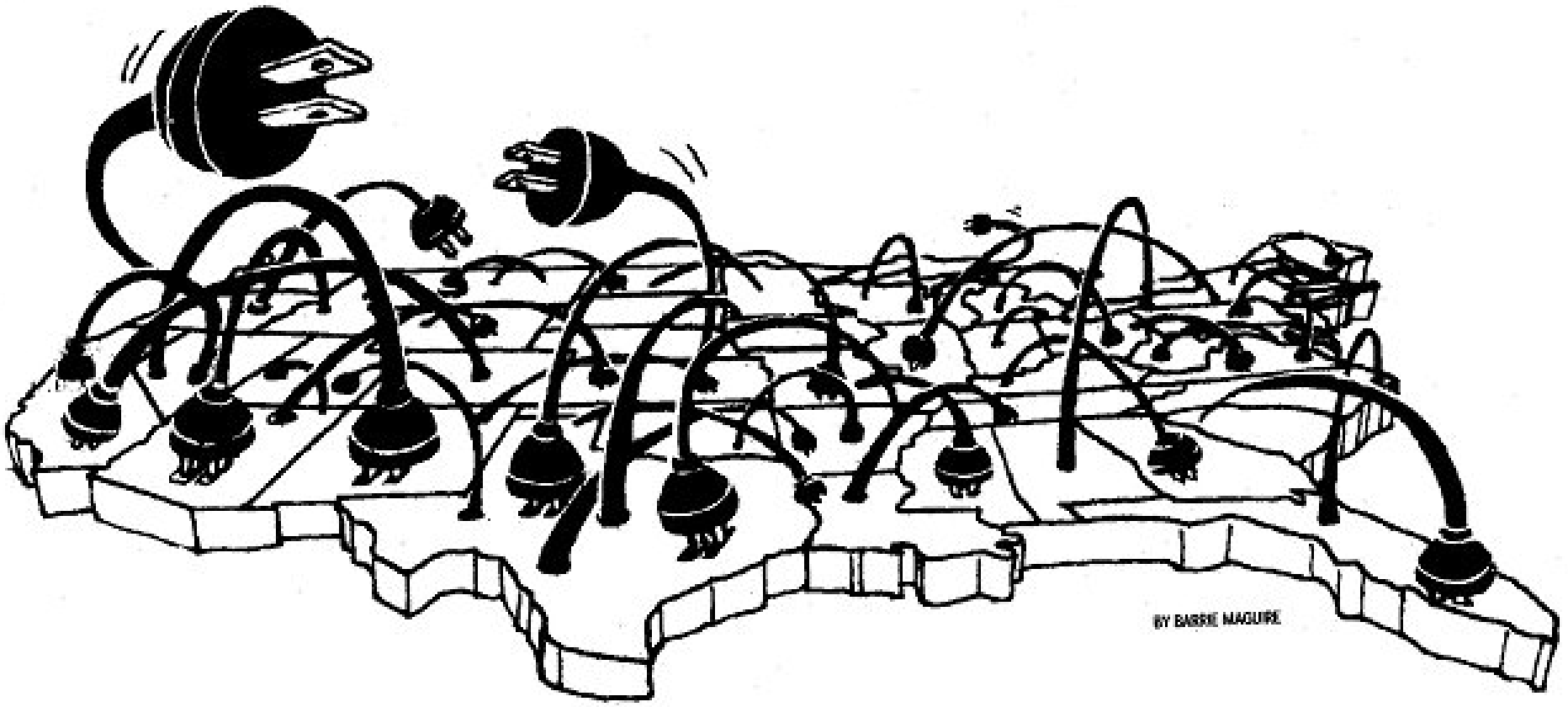
Source: EIA, Annual Energy Review 1996

Installed Transformer Banks in the U.S.



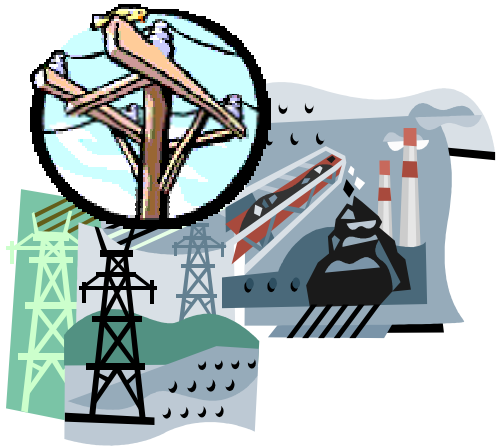
Source: Waukesha Electric Systems 1997

National "Gridlock"

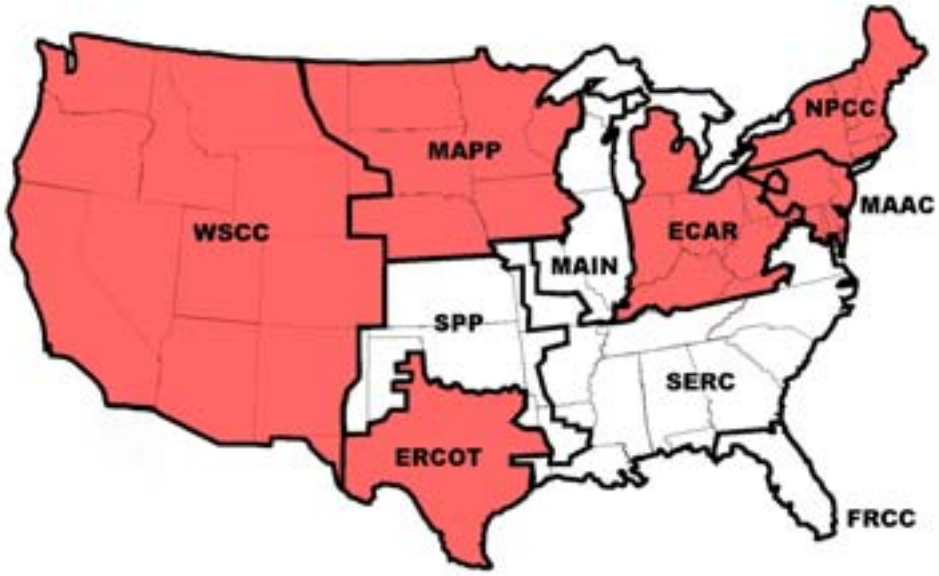


Electric Power Constraints

"If the energy infrastructure of this country is inadequate or in some way excessively costly, it will undermine economic growth, and is therefore a major issue that must be addressed."
***Alan Greenspan**, January 26, 2001*



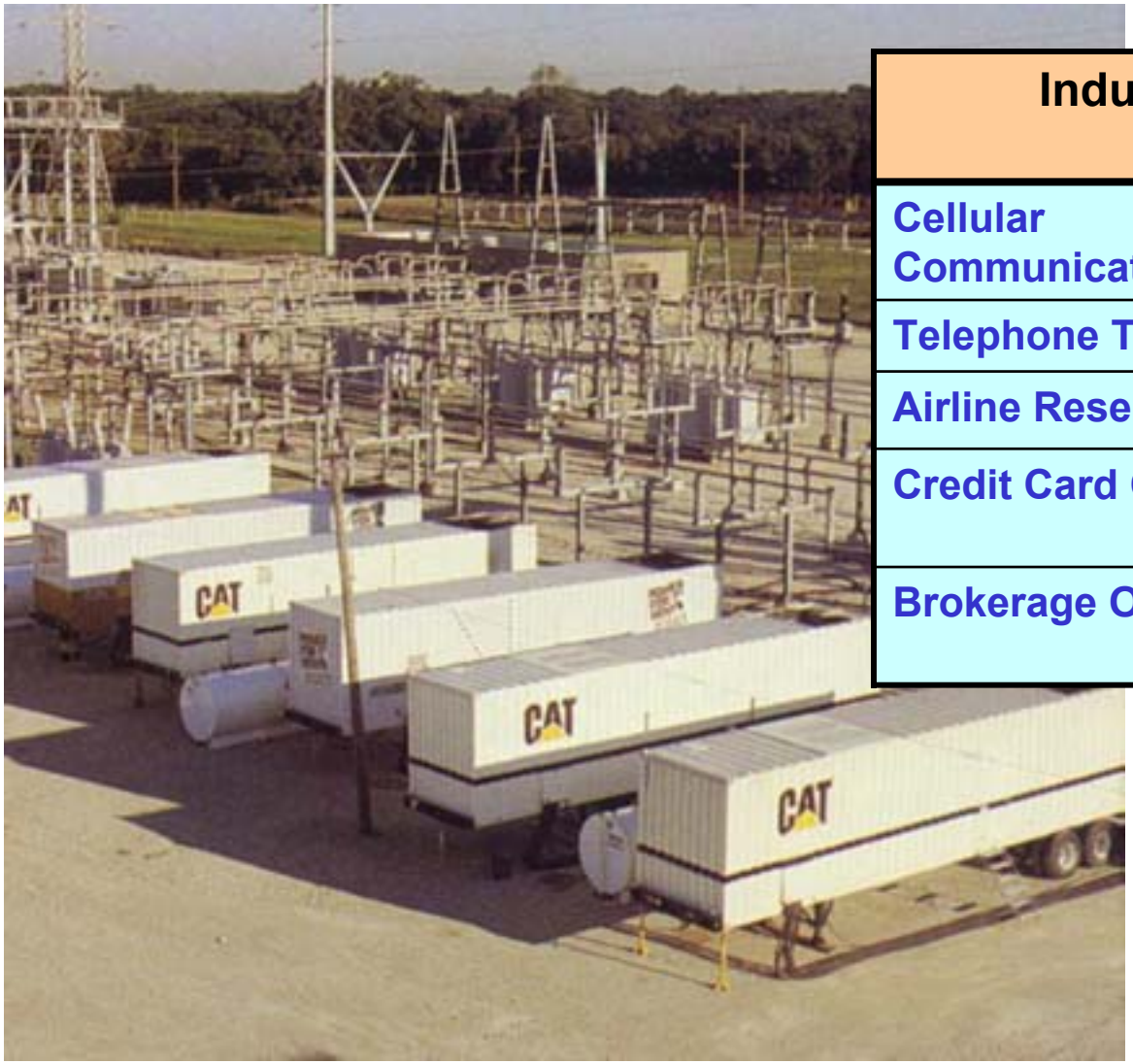
2009 Projections



Areas with Capacity Margins < 10 percent

Source: National Electricity Reliability Co

Power Reliability Costs



Industry	Average Cost of Downtime
Cellular Communications	$41,000 per hour*
Telephone Ticket Sales	$72,000 per hour**
Airline Reservations	$90,000 per hour**
Credit Card Operations	$2,580,000 per hour**
Brokerage Operations	$6,480,000 per hour**

*Teleconnect Magazine

**Contingency Planning Research-1996

NOx Emissions Limits

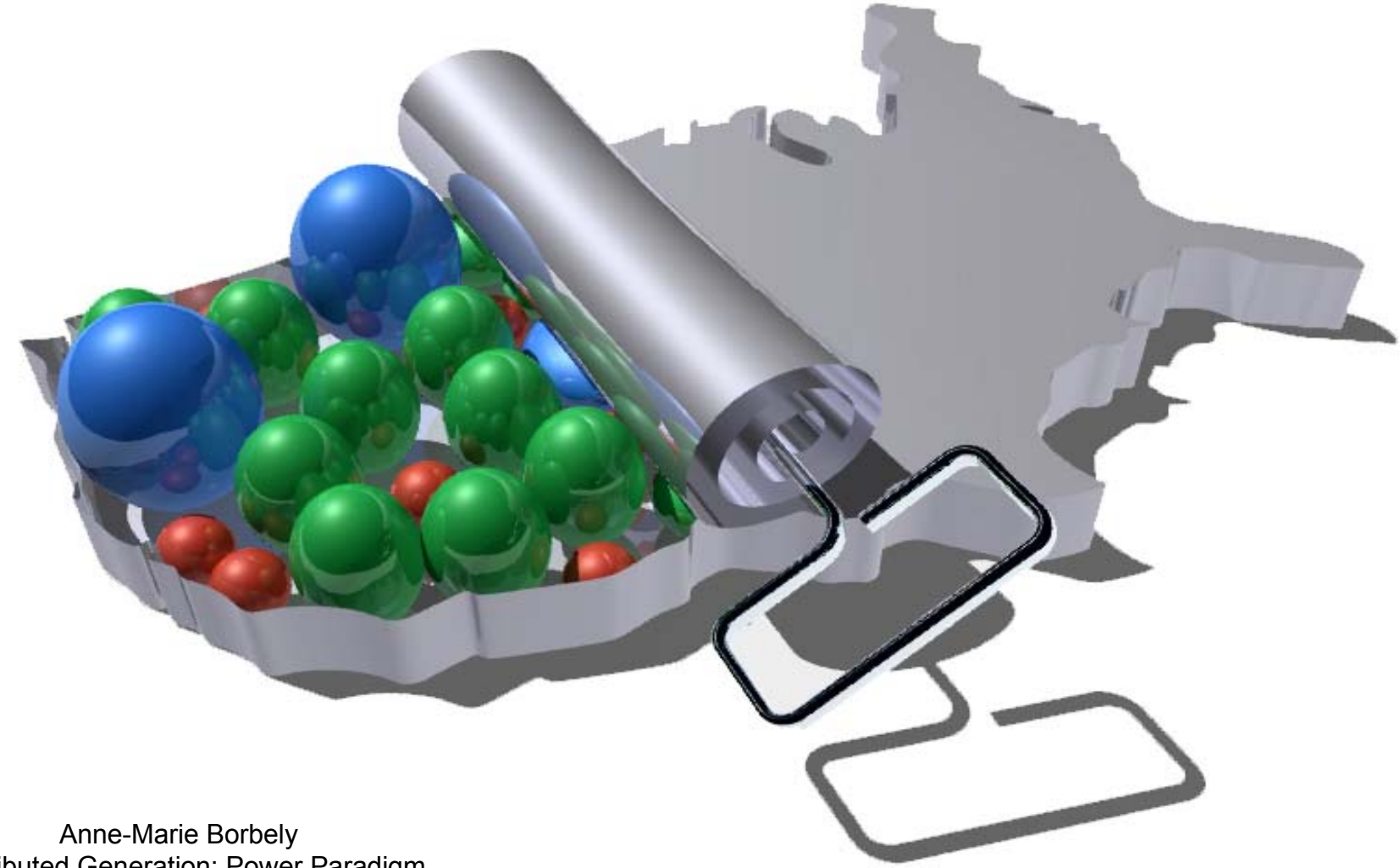
> 25 ppm

< 5 ppm

Advantages of DER

- Diversity of energy supplies – Fuel Flexible
- Fuel flexibility and distributed system enhance energy security
- DER Systems with increased power reliability over grid
- Flexible electric power grid
- Distributed on-site locations (ideal for remote locations with no grid infrastructure or areas with capacity constrained grid)
- Technologies with low emissions profiles

Move Toward Customization of Energy



Anne-Marie Borbely
"Distributed Generation: Power Paradigm for the New Millennium"

Mission

- Improve the efficiency and reliability of generation, delivery and end-use
  - -while maintaining increased security and reliability
- High-risk research
  - - public/private partnerships
  - - performance based programs
  - - metrics on efficiency, cost and emissions
- Increase Security and Reliability

Office of Power Technologies' Goals

- Enable DER to achieve 20 percent of new generation capacity by 2010
- Enhance the use of renewable energy, triple the installed capacity of non-hydroelectric renewables for 2010
- Maintain the present high reliability of the nation's electricity system.

OPT Priorities

- Infrastructure
  - Hydrogen
  - Superconductivity
  - Transmission and distribution
- Technology "generation/heat" choices
  - Renewables
  - Fuel Flexible gas-based generation technologies
  - Heat utilization technologies and package systems
  - Hydrogen technologies (Fuel cells)
- End-use integration
  - Energy optimization research
  - State Activities/National Standards

Office of Power Technologies

Renewable Energy

- Biopower
- Solar Technologies
- Wind
- Geothermal
- Hydrogen
- Hydropower

Natural Gas Technologies

- Industrial Gas Turbines
- Microturbines
- Thermally Activated Technologies
- PEM Fuel Cells
- Internal Combustion Engines
- Balance of Plant (hybrids, CHP, sensors)

Transmission and Distribution Infrastructure

- Power Delivery
- Superconductivity
- Transmission Reliability
- Energy Storage
- Smart Controls
- Interconnection

DER Program

- Interior
  - Technology R&D
    - Microturbines
    - Reciprocating Engines
    - Low Emissions (gas turbines)
    - Thermally activated technologies (chillers, desiccants)
    - Technology Base (fuel flexibility, materials)
  - End-use systems Integration
    - High Tech Industry Solicitation to be awarded on 02
    - Industrial Contracts (finishing)
    - Package Systems (CHP) Research
    - Communications and Controls
- Energy and Water
  - Distributed Energy Systems
    - Transmission
    - DER integration into the Distribution System
    - Storage

DER Funding Summary
($M)

Program Element	Fiscal Year 2002	FY 03 Request
Advanced Turbine Systems	0	0
Low Emissions Gas Turbines	4.50	4.50
Microturbines	11.0	7.0
Reciprocating Engines	11.0	11.0
Fuel Cells	5.50	7.50
Technology Base	8.256	8.256
Absorption Heat Pumps/Chillers	11.6	4.6
Dessicants		
Fuel Flexibility (oil)	0.5	0.5
Industrial Distributed Generation/High Tech/Controls	4.95	7.338
Package Systems R&D/CHP	6.5	12.0

Program Element	Fiscal Year 2002	FY 03 Request
Transmission Reliability	18.307	7.720
DER Integration in the Distribution System	10.842	7.249
Energy Storage	9.159	7.640

Total FY02	102.114
Total FY03 Request	85.303

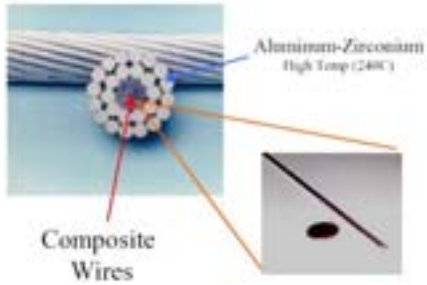
Program Portfolio

Fuel

Technology Development: Microturbines, reciprocating engines, fuel cells, materials, storage

Technology Packages: Integrated CHP systems, chillers, desiccants

End-use Integration: Demand management, controls, sensors



Electric and Gas Integration: Load management, sensitive loads, power electronics

Distribution System: Load management, power parks, microgrids, storage, ups, control, DC grids

Transmission System: wire materials, tools

Distributed Gas Fired Technologies

Microturbines

2000
- $900-$1,200/kW
- 17-30% Efficiency
- Double digit ppm NO_x

2007
- Cost competitive with the market
- 40% Efficiency
- Single digit ppm NO_x

Fuel Cells

1997
- $4,000-$10,000/kW
- 80 degrees C
- Natural gas and propane fuels

2010
- $600/kW
- 120-140 degrees C
- Multiple fuels

Gas Turbines

1992
- 29% efficiency
- Double digit NO_x
- $600/kW

2001
- 38% Efficiency
- Single digit NO_x
- $400/kW

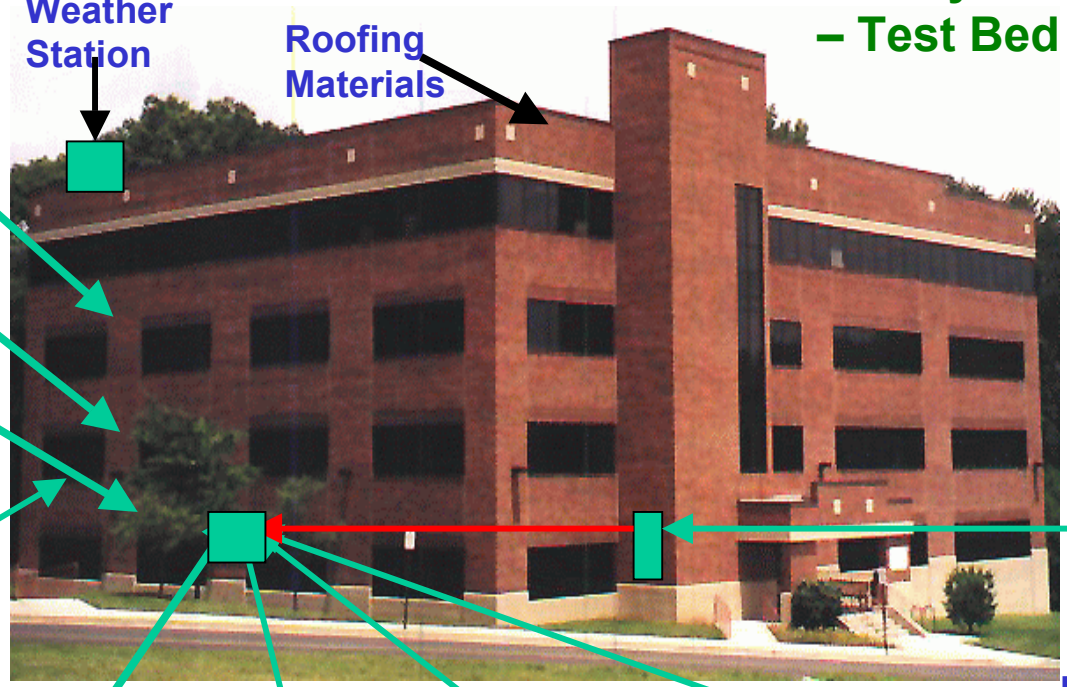
2010
- Cost competitive with the market
- <5 ppm NO_x

Reciprocating Engines

2000
- $300-$400/kW
- 25-40% Efficiency
- 2-3 grams/kWh NO_x

2007
- Cost competitive with the market
- 50% Efficiency
- < 0.15 grams/kWh NO_x

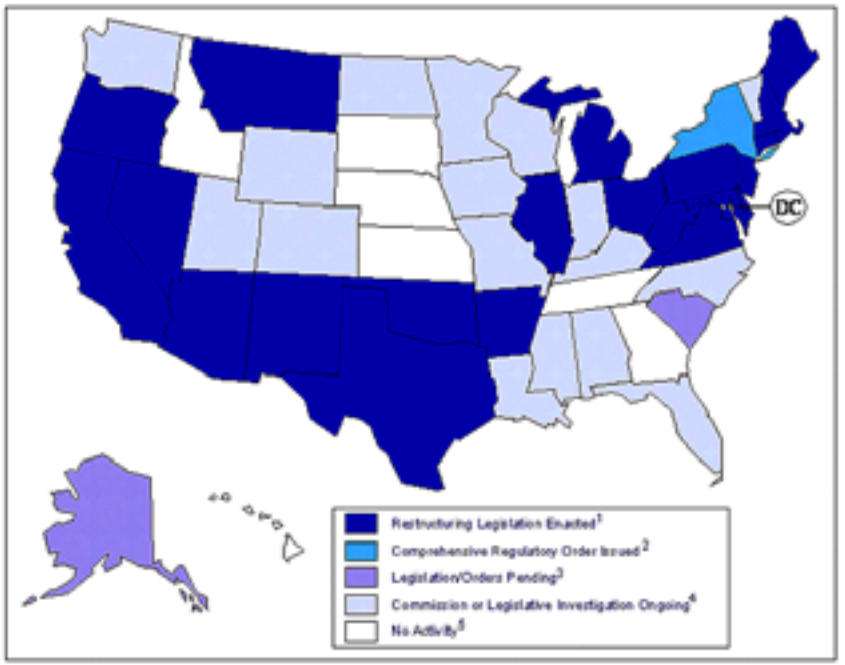
Integration of Distributed and CHP Systems



Key State Activities

States/regions play critical role in eliminating the barriers to and developing the markets for CHP

- Output-based emissions standards
- Uniform Interconnection Standards
- Building Codes and Standards



Source: Energy Information Administration, October 2000.

"Model Rule"

Output Based Standards, Credit for CHP, Emissions Values Based on Usage (backup, peaking, base), Attainment/Non-attainment

- Regulatory Assistance Project is an organization that provides assistance and support to state energy and environmental officials
- Workgroup includes state energy and environmental officials, environmentalists, EPA, industry reps

Interconnection Standards

- General Requirements
  - Voltage Regulation
  - Integration with Area EPS Grounding
  - Synchronization
  - Secondary and Spot Networks
  - –Inadvertent Energizing of the Area EPS
  - –Monitoring
  - –Isolation Device
- Response to Area EPS Abnormal Conditions
  - Voltage Disturbances
  - Frequency Disturbances
  - Disconnection for Faults
  - –Loss of Synchronism
  - –Feeder Reclosing Coordination
- Power Quality
  - Limitation of DC Injection
  - Limitation of Voltage Flicker Induced by the DR
  - –Harmonics
  - –Immunity Protection
  - –Surge Capability
- Islanding

Building Codes and Standards DER Road Shows

- One day, eight-hour session with State Certification of Inspectors
- Purpose: to introduce local building and fire code inspectors to DER technologies with a “hands-on” experience
- Manufacturers present on their product, the installation/permitting process, with or without specific reference
- Alt. fuels and electrical interconnection may also be covered
- State PUC, energy office, and EPA regulators generally participate as well.
- IMPORTANT – Local regulators indicate which technologies, applications and fuel sources are of interest. Agenda is not fixed in advance.

Sample Topics

- RTO/ISO communications requirements
- Real-time pricing, demand markets
- IT: Substation automation, AMR, home gateways
- Management & valuation of intermittent resources (wind, PV)
- Contracting – capacity, energy, PF, ancillary svcs.
- Financing, insurance, liability assessment
- Environmental assessment, efficiency credits, arbitrage
- Utility interconnection
- Building and fire code development

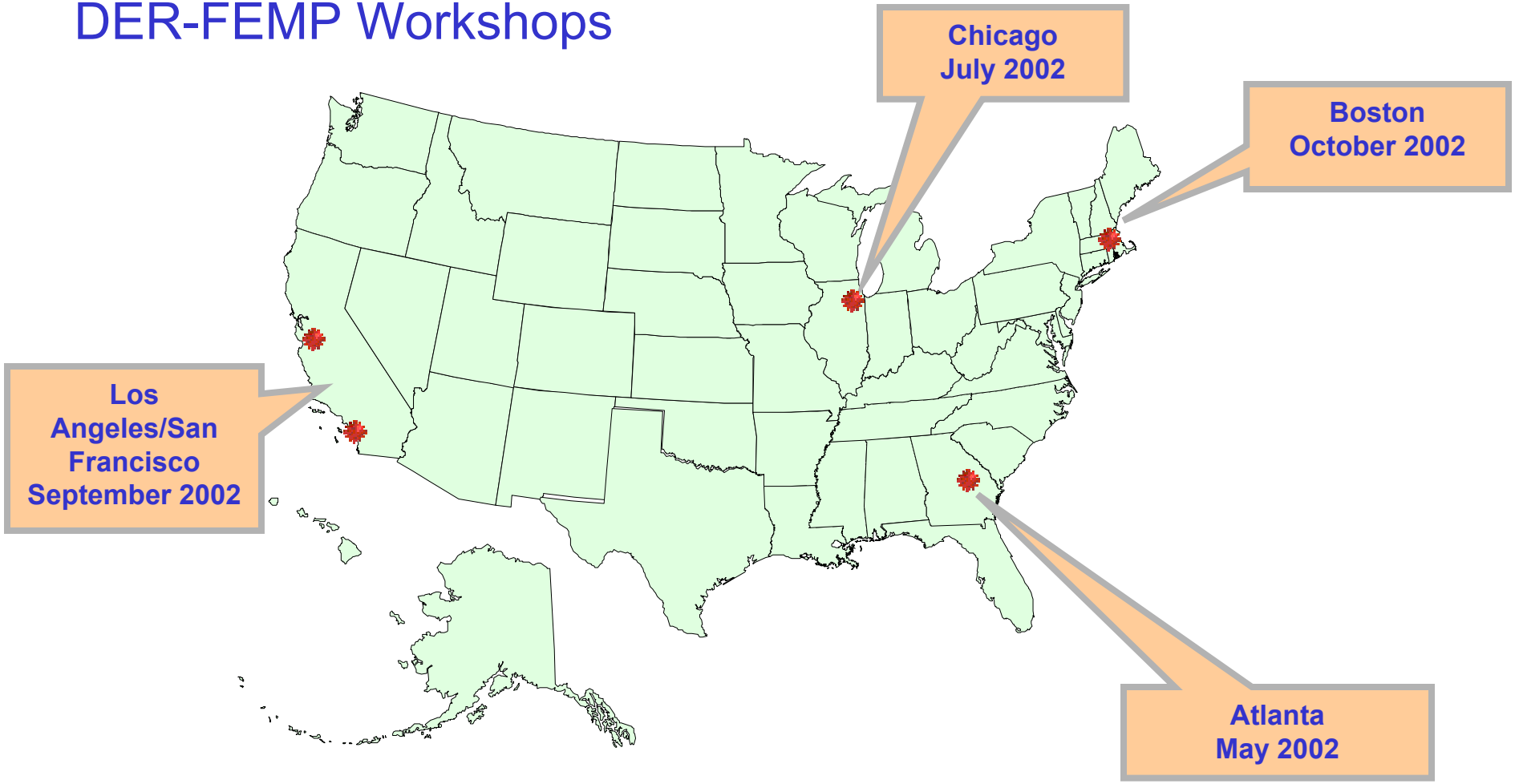
Application Centers

University of Illinois-Chicago: Midwest Regional CHP Applications Center

- facilitate CHP projects, technical assistance
- region-specific information, application knowledge

Federal Energy Management Program

DER-FEMP Workshops



State Energy Program

2002

- Solicitation open until March 15
- DER - $1.24M
  - DG
  - CHP and CHP for Brownfields
  - Fuel Cells
  - Communication & Controls
- Energy Storage - $125K
- Interconnection - $55K

SEP 2001

- SEP projects and State Initiative Solicitation address regulatory and institutional barriers at the state and regional level
  - FL CHP Protocol/Demo
  - HW Identifying CHP Opportunities and Barriers
  - IL CHP Environmental Permitting Guidebook
  - IA Guidelines for permitting and barrier removal
  - VA Overcoming CHP barriers

Regional Office Activities

- CHP Initiatives in MW, NE, and NW
- Chicago RO cosponsors w/Ohio –workshop on Onsite Energy options for Ohio Business and Homeowners
- Philadelphia RO staff meet with Clean Air Council
- Seattle RO participate in workshop on Geothermal options for Nevada
- Atlanta RO participate in Georgia Goveners Energy Task Force

Working Together

- www.eren.doe.gov/der
- Technical publications
- Workshops and conferences
- Technology planning
- Cost-shared RD&D

Information Clearinghouse and Networking